

This workflow was developed at an iDigBio workshop in January 2015. The most recent version is available at <https://github.com/iDigBioWorkflows/FlatSheetsDigitizationWorkflows> and <https://www.idigbio.org/content/workflow-modules-and-task-lists>.

Appendix S2. Module 2: Selecting Components for an Imaging Station

Task ID	Task Description	Explanations and Comments	Resources
T1	Determine budget.	<p>Options for imaging stations vary according to available budget.</p> <p>Imaging stations that include full-frame cameras and high-quality lighting might cost between \$3000 and \$9000, though less expensive options are available, and custom-made setups can be much cheaper.</p> <p>This document does not include recommendations for a custom-made option.</p>	<p>See: iDigBio Imaging Equipment Recommendations: https://www.idigbio.org/wiki/images/8/86/IDigBioImagingGeneralEquipmentRecommendations1_0.pdf.</p>
T2	Assess collection size and scope.	<p>Consider the types of collections to be digitized. For herbaria, types might include some or all of the following: standard herbarium sheets, larger than standard herbarium sheets, packeted or boxed collections, bound exsiccatae, fluid collections, microscope slides, separate fruit collections, and otherwise bulky materials.</p>	
T3	Determine available support.	<p>Find potential collaborators and peers in the community who have experience in using various equipment and workflows and who might provide support and help solving common problems.</p> <p>Also consider seeking out others in the community who would be willing to share costs and/or equipment.</p>	<p>Several listservs might be helpful here, including:</p> <ul style="list-style-type: none"> • Digitization listserv at iDigBio (idigbiodigi-l); see https://www.idigbio.org/wiki/index.php/IDigBio_Listservs • Herbarium listserv, herbaria@NACSE.ORG
T4	Assess space and environmental conditions for	<p>If variable ambient light is unavoidable, a light box may be better than a copy stand.</p>	<p>Obtain an accurately measured floorplan for the facility showing doors</p>

	imaging station(s).	<p>The location of the imaging station should include access to sufficient power outlets and a network connection.</p> <p>Imaging equipment should be placed on a stable surface to reduce vibrations that will affect image quality and should be placed in a location where it can remain undisturbed for the duration of imaging.</p> <p>A large-scale conveyor belt system will require greater area than a single camera setup.</p>	and windows to assist in determining station placement.
T5	Consider ergonomics of work environment.	A U-shaped desktop created by a bench and two carts might be an efficient approach; a cart for pre-imaged specimens to the left of the imager, an imaging station on a table in front, and a second cart on the right to receive specimens following imaging.	
T6	Determine acceptable resolution.	Resolution should ideally be at least 16 megapixels per image. If using a scanner, 600 ppi is preferred.	
T7	Choose image capture equipment.	Select between scanner and camera. Scanners often have a higher resolution, but imaging time per specimen is greatly increased and the thickness of some specimens renders them unsuitable for scanning. Most herbaria use cameras for general specimen imaging.	
T8	Camera choice criteria.	<p>Full-frame image sensor is recommended over cropped image sensor; a full-frame sensor captures more data and generally provides a better image quality.</p> <p>Autofocus cameras are recommended.</p> <p>Minimum standard for best practice is full-frame DSLR with at least 12</p>	<p>See: iDigBio Imaging Equipment Recommendations: https://www.idigbio.org/wiki/images/8/86/IDigBioImagingGeneralEquipmentRecommendations1_0.pdf.</p>

		<p>megapixel capacity. As of this writing, many DSLR cameras with full-frame sensors of 16-36 megapixels are available and preferable, if budgets allow.</p> <p>Consider cameras with available associated software that allows the camera to be tethered to and controlled from a computer. See T15.</p>	
T9	Lens choice criteria.	<p>Lens choice and focal length are dependent upon the camera's image sensor size and distance from the imaging surface (the area where the specimen is placed).</p> <p>A macro lens is recommended (1:1 fidelity). Zoom lenses are not recommended. Lenses should be compatible with the camera body without requiring an adapter.</p> <p>To capture a full herbarium sheet with minimal background (to avoid cropping), a 50-mm macro lens is recommended for a full-frame image sensor positioned about 29 inches from the imaging surface. A different focal length will be required for cropped image sensors, depending on the crop factor. If using OR Technology light box, a 50-mm lens is required for full-frame cameras.</p> <p>Autofocus lenses perform well and are preferred by herbarium personnel. Others recommend manual focus with an anti-creep device. If problems with creep are encountered, gaffer tape can be placed on the barrel of the lens.</p>	<p>See: iDigBio Imaging Equipment Recommendations: https://www.idigbio.org/wiki/images/8/86/IDigBioImagingGeneralEquipmentRecommendations1_0.pdf.</p>
T10	Copy stand criteria.	<p>Stronger stands are better, as they provide stability to avoid camera shake. Size of the base and height of the post are also important. Copy stand should be large enough to accommodate objects to be photographed; post should</p>	<p>See: iDigBio Imaging Equipment Recommendations: https://www.idigbio.org/wiki/images/8/86/IDigBioImagingGeneralEquipmentRecommendations1_0.pdf.</p>

		accommodate full range of focal distance anticipated for objects being imaged.	
T11	Light source criteria.	Options include a light box, flash units, LED, and fluorescent lights. Consider how much ambient light is in the room where the imaging equipment will be located. Ambient light may affect consistency in image quality by producing uneven color or exposure across an image. Boxes, which provide an enclosed space with even, shadow-free internal light, are least affected by ambient light. Flash units and LED and fluorescent lights, generally placed above and on each side of the specimen, allow for easier movement of specimens; however, shadows may be conspicuous and distracting in the resulting image, depending on angle and position of the light source.	See: iDigBio Imaging Equipment Recommendations: https://www.idigbio.org/wiki/images/8/86/IDigBioImagingGeneralEquipmentRecommendations1_0.pdf .
T12	AC power supply for camera.	A camera battery cannot support the workload for long periods of imaging. AC power adapters are required, and are unique to the camera purchased.	
T13	USB cable to connect camera to computer.	USB cables should be long enough to connect to the camera when elevated well above the table surface. USB extension cables are available.	
T14a	Dedicated computer.	A dedicated machine with at least 4 GB RAM, a 500-GB hard drive (larger is better), and at least an i5 processor is recommended.	
T14b	Dedicated monitor.	Should be large enough to view several windows or programs side by side. Two monitors attached to the imaging computer are useful but not essential, with one monitor oriented landscape and one portrait; the portrait orientation is very useful for proofing images during QC.	
T15	Camera control	Allows the camera to be controlled	

	software.	<p>from the computer (tethering). The particular software depends on the camera. Most Canon DSLR cameras include the remote shooting software EOS Utility and Digital Photo Professional with purchase. Nikon's Camera Control Pro and CaptureNX are sold separately.</p> <p>Free camera control software is also available, including digiCamControl (http://digiCamControl.com/).</p>	
T16	Other software.	<p>Additional software may be needed to post-process, rename, and crop images, or to capture image metadata. These might be commercial products, including Photoshop and Lightroom, or open access products, including Gimp and Lightzone.</p> <p>Some institutions have created custom programs or scripts to facilitate these steps, and make their code available for others to use. See the Image Processing Module for more information about possible software solutions.</p> <p>FTP or similar software may be required to upload images to a processing center.</p>	<p>Image processing software. File transfer program. Image Processing Module.</p>
T17	Data storage system.	<p>Consider hardware and software requirements for short-term storage and backing up of images (e.g., a RAID configuration). For information about backing up your images refer to the DATAOne Best Practices.</p> <p>See the Image Archiving Module for information about true medium- to long-term digital preservation of images.</p>	<p>See: DATAOne Best practices for backing up data: https://www.dataone.org/best-practices/backup-your-data.</p>
T18	Color standard (or target or checker) and grayscale.	<p>A color standard or target is required for image capture and archiving to allow for later calibration of image exposure and color balance. At a</p>	<p>Tiffen (Kodak) Color Separation Guide and Gray Scale.</p>

		<p>minimum, color targets should include white and black points as well as red, blue, and green. Ensure the availability of a legend to facilitate monitor calibration.</p>	<p>Micro Nano Checker: https://docs.google.com/viewer?as=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnx0dGR0Y258Z3g6NDM2MTQ5NiM1NGNkMGVmOQ.</p> <p>X-Rite ColorChecker Targets: http://xritephoto.com/product_overview.aspx?catid=28.</p>
T19	Scale.	<p>A scale with units in cm and mm is preferred. The scale may be free-floating for placement on the surface of each specimen sheet during imaging, or it can be affixed to the margin of the imaging area where it will be visible in a fixed location in each image.</p>	
T20	Consider if any customizations to hardware will be required.	<p>Light boxes may require modifications or additions to the box top to provide a stable mount for the camera; in some cases a copy stand can provide this mount.</p> <p>The imaging surface should allow the specimen to be consistently positioned each time. As one option, a square corner creating two adjacent raised edges along one edge of the surface works well, and can be easily created with a carpenter's square or something similar.</p> <p>Consider also the background surface and color. Velveteen or velvet paper, or poster board can provide an even background if desired, and can be easily replaced as it becomes worn or marked. Black is preferred.</p>	

Literature Cited

DataONE. Backup your data. <https://www.dataone.org/best-practices/backup-your-data>. Accessed 1 May 2015.

iDigBio. iDigBio Imaging equipment recommendations.

https://www.idigbio.org/wiki/images/8/86/IDigBioImagingGeneralEquipmentRecommendations1_0.pdf. Accessed 1 May 2015.